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Mutagenic effectiveness and efficiency of gamma rays in snake gourd (*Trichosanthes anguina* l.)

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Abstract: The present experiment was undertaken to determine the mutagenic effectiveness and efficiency of gamma rays on different biological parameters in snake gourd. The research was conducted in two generations namely M_1 and M_2 during spring-summer season (mid- February) of 2012 and 2013 at the Horticulture research station, Mondoury, Bidhan Chandra Krishi Viswavidyalaya. The parent material, selfed seeds of *BCSG-28* variety were irradiated with 100 Gy, 150 Gy, 200 Gy, 250 Gy and 300 Gy doses of gamma rays. The seeds along with control were space planted for raising M_1 generation. Each M_1 plant was harvested separately and desirable M_1 individual plant progeny rows were laid in RBD for raising M_2 generation. The effectiveness and efficiency of the mutagen used was assessed from the data on biological damage in M_1 generation. In M_1 generation, results showed a dose dependent retardation in biological parameters like seed germination, plant survival and 200 Gy was depicted as LD_{50} indicating less damaging effect at lower doses on genetic material. In M_2 generation, Lower doses 100 Gy (28.80 effectiveness, 21.58 efficiency) and 150 Gy (18.33 effectiveness, 8.68 efficiency) treatments were found as effective and efficient and a wide range of induced variability was observed in almost all traits. The mutants with short fruit, higher fruit diameter and reduced vine length were isolated in M_2 generation.

Keywords: Gamma rays, Grey (Gy), Mutagenic effectiveness, Mutagenic efficiency, Snake gourd

INTRODUCTION

Snake gourd (*Trichosanthes anguina* L.), a monoecious minor cucurbit having 2n=22, plays an important role in human diet. Snake gourd is a commonly grown vegetable in the country, originated in Indian Archipelago and widely distributed in humid tropical areas of many countries, including Southeast Asia, China, Japan, Australia, Fiji, Mauritius, Java, South America and some parts of America. In India it is cultivated in Kerala, Tamilnadu, Meghalaya, Tripura, Assam, West Bengal and Odissa. Flowers are white in colour and fringed. The fruits are long narrow, cylindrical, slender, long tapering and may vary from 1-6 feet in length. It is important as a good source of minerals, fibre and nutrients to make the food wholesome and healthy (Ahmed *et al*., 2000).

Mutations occur in natural populations spontaneously at a low rate. Mutation offer a great scope in breeding any crop and can be incorporated into cropping programme as conventional allow obtaining genotypes with desirable traits (Ahloowalia *et al*., 2004). So, induction of mutation through radiation or chemicals are now very common worldwide to boost up crop wealth and food security. The FAO estimates that about 800 million people do not have enough food to eat. Global food security continues to be the central issue to cope up with the ever growing human population (Kharkwal and Shu 2009). Sheeba *et al.,* (2005) reported that in *Sesamum indicum* L. seed germination, seedling survival, plant height and pollen fertility were reduced significantly with the increase in dosage levels of both gamma rays and EMS. Adamu *et al.* (2002) also recorded decreased seedling emergence, seedling height and root length, and seedling survival in groundnut with the treatment of gamma rays. Kumar and Yadav (2010) had reported significant plant height reduction in sesame due to higher doses of mutagenic treatment. The efficacy of any mutagen in plant breeding depends on its effectiveness and efficiency (Konzak *et al.,* 1965). Induced genetic variability is essential for any crop improvement programme and its creation and management are central to plant breeding. The present investigation was carried out to determine LD_{50} in M_1 generation and to assess the efficiency and effectiveness of gamma ray mutagen in M_2 generation in snake gourd.

MATERIALS AND METHODS

The parent materials used in the present experiment was selfed seeds of *BCSG-28*, a local variety of snake gourd with green rind colour with distinct white stripes and smooth surface, elongated, 50-55cm in length and 3.5-4.5 cm in girth. Uniform, healthy and dry seeds of

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snake gourd were irradiated with different doses viz. 100, 150, 200, 250 and 300 Gy (Grey) of gamma rays (source: ^{60}Co) Jadavpur technical campus, Department of Atomic Energy, Kolkata. Next day morning, treated seeds of each dose and control were sown during spring-summer (mid-February) 2012 for raising M_1 generation.

Seed germination was calculated as proportion of seeds germinated in each treatment including control and it was recorded 25 days after sowing in the field. Plant survival was calculated as proportion of plants survived until maturity in each treatment including control. LD_{50} was depicted by drawing graph of plant survival % versus dosage of gamma rays. In M_2 generation, M_1 plant progeny rows were raised and mutants were observed.

Assessment of mutation frequency, mutagenic effectiveness and efficiency: Individual plants of the treatments including control were harvested separately in treatment wise and desirable M_1 mutants were raised in M_2 generation; then mutation frequency, Mutagenic effectiveness and efficiency were calculated (Konzak *et al.,* 1965) and expressed in percentage.

Mutation frequency: On M_2 plant basis (% of mutated M_2 plants) Mutation frequency was estimated as per cent of segregating M_1 Plant progenies (Gaul, 1964).

Mutagenic effectiveness: The ratio of "factor mutations to doses" means frequency of a given mutation at a given dose of mutagen employed. Mutagenic effectiveness was calculated by the formula :

$$\text{Mutagenic Effectiveness} = \frac{\text{Mutation frequency in } M_2}{\text{Dose of mutagen (kR)}}$$

Where, Gy=Grey, 10 Grey= 1 kR (kilo Roentgen of gamma rays)

Mutagenic efficiency: The ratio of "Factor mutations to biological damage" means desirable changes free from associated undesirable changes on mutagenesis. Mutagenic efficiency was calculated by the formula:

$$\text{Mutagenic Efficiency} = \frac{\text{Mutation frequency in } M_2}{\text{\% lethality or sterility in } M_1}$$

Where, Lethality was calculated as percentage of plant survival reduction and sterility was calculated as per cent of seed fertility reduction.

RESULTS AND DISCUSSION

Data on germination and plant survival are presented in Table-1. In M_1 generation dose dependent retardation in seed germination was observed. As compared to control maximum seed germination was recorded 93.33 per cent, followed by 81.66 per cent in the 100 Gy and 150 Gy treatments respectively while minimum seed germination was recorded to be 36.66 per cent at highest dose 300 Gy (Table-1). Similar results have been observed by Kumar and Yadav (2010). It was observed that increase in radiation dose, reduced germination percentage, which was also recorded by Ciftci *et al.,* (2006) and Kumari and Singh (1996). Similarly seed germination percentage and plant survival also decreased with increased dose of γ-ray in the present experiment. It indicates that significant increase in lethality takes place at higher doses of mutagen. The similar results have been revealed by Vinod and Sharma (1998). The dose 200 Gy was found out to be the LD_{50} as it recorded fifty per cent plant survival (Table-1). The same trend was also noted by Shevchenko *et al.,* (1990) in pea and Omar *et al.,* (2008) in chilli. Genetic variability has been reported to increase in doses of gamma rays (Gupta, 1970)

The mutagenic effectiveness is a measure of point mutations induced by a unit dose of mutagen while mutagenic efficiency represents the proportion of mutation in relation to the associated undesirable biological effects, such as chromosomal aberration, lethality and sterility induced by mutagen (Konzak *et al*., 1965). In fact the ratio of chlorophyll mutations induced in M2 generation to the various biological damages induced in M1 generation such as lethality, and pollen sterility indicates efficiency of a mutagen. In M_2 generation, mutagenic effectiveness and efficiency of the mutagen exhibited inverse relationship with increase in dose (Table-2). Most effective (28.8 %) and efficient (21.58 %) gamma radiation dose was 100 Gy on the basis of mutant plants in M_2 generation. Lower doses of gamma rays recorded higher efficiency in the present study which is in tune with the findings of Paul and Singh (2005). Maximum number of mutated plants are observed in 100 Gy and 150 Gy (3) followed by 200 Gy (2). The highest mutation frequency was observed in 100 Gy (2.88) followed by 150 Gy (2.75). The low variability for efficiency can be interpreted by assuming that the extent of damage in M_1 generation determines the mutability of genes, irrespective of mutagen used. Similar results also recorded by Gautam *et al.,* (1992) and Sharma *et al.,* (2006) in Urdbean. The decrease in seed germination induced by mutagenic treatments may be the result of damage of cell constituents at molecular level or altered enzyme activity (Khan and Goyel, 2009; Chowdhury and Tah, 2011). Srivastava *et al.* (2011) suggested the reduction in seedling survival of wheat was due to the hindrance caused by the mutagen on different metabolic pathway of the cells.

Conclusion

The experimental results revealed maximum seed germination percentage (93.33) and plant survival percentage (86.66) of snake gourd, *Trichosanthes anguina* in 100 Gy after the control (100, 100 respectively). 200 Gy was noted LD_{50} and the lower doses (100 Gy and 150 Gy) are more effective and efficient. The mutants with short fruit, higher fruit diameter and reduced vine length were isolated in M_2 generation. Lower effective doses of gamma rays may contribute to considerable utility.

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Table 1: Estimation of seed germination (%) and plant survival (%) in M_1 generation

S N.	Dose	Seed germination percentage (%)	Per cent reduction	Plant survival percentage (%)	Per cent reduction
1.	Control	100	00.00	100	00.00
2.	100 Gy	93.33	6.67	86.66	13.34
3.	150 Gy	81.66	18.34	68.33	31.67
4.	200 Gy	58.33	41.67	50.00	50.00
5.	250 Gy	43.33	56.67	38.33	61.67
6.	300 Gy	36.66	63.34	26.66	73.34

Table 2: Assessment of Mutagenic Effectiveness and Mutagenic Efficiency in M_2 generation.

S N.	Dose	M_2 plant population	Number of M_2 plants mutated	Mutation frequency (Mf)	Lethality or per cent plant survival reduction (L)	Mutagenic effectiveness Mf X 100/ Dose	Mutagenic efficiency Mf X 100/ L
1.	Control	-	-	-	-	-	-
2.	100 Gy	104	3	2.88	13.34	28.80	21.58
3.	150 Gy	109	3	2.75	31.67	18.33	8.68
4.	200 Gy	103	2	1.94	50.00	9.70	3.88
5.	250 Gy	102	1	0.98	61.67	3.92	1.58
6.	300 Gy	106	1	0.94	73.34	3.13	1.28

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